Overview of Recent 6G Standardization Activities and Analysis of SNS Contributions

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Abstract— This paper offers an in-depth update on global 6G standardization efforts and the role of SNS-JU projects in shaping them. It reviews progress in key bodies like 3GPP, ETSI, and ITU, emphasizing their impact on 5G Advanced and early 6G development. It highlights how these efforts enhance interoperability, support European leadership, and drive innovation in AI, spectrum use, and infrastructure. The role of 6G-IA in pre-standardization is also explored, showing alignment with regulatory and industry goals. The paper showcases SNS-JU contributions and concludes with recommendations on collaboration, policy alignment, and boosting global standardization input.

I.   INTRODUCTION

As 5G deployment continues, global R&I efforts toward 6G have begun, aiming to create AI-native networks with innovations like RIS, ISAC, and THz spectrum. A unified global 6G standard—led by SDOs like 3GPP, ETSI, and ITU—is essential for interoperability and market success. However, navigating standardization processes is complex, especially for researchers and SMEs. To support this, the SNS JU has established Working Groups and tools like the Standards Tracker to monitor and guide contributions. Based on these sources, the SNS ICE CSA project [1] has performed an overview of the current standardization landscape on 6G [2], which is presented in this paper. It also outlines a number of pre-standardization activities, SNS JU project contributions, and related recommendations.

II.   RECENT ACTIVITIES AT 3GPP TOWARDS 6G

3GPP's 2024 roadmap included key steps toward 6G and continued 5G advancements. A major SA1 update in September 2024 introduced the 6G study timeline for Release 20 (spanning 21 months, as shown in Figure 1), with normative 6G work to start in Release 21.
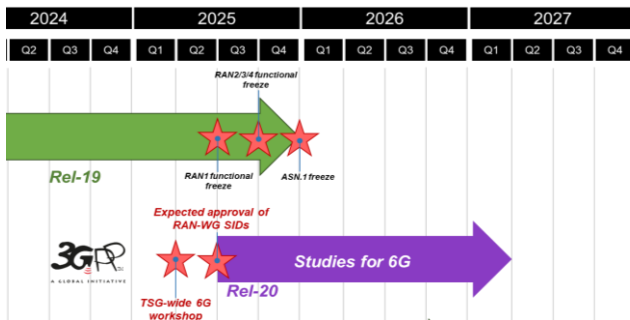

Figure 1: 3GPP timeline for 6G and 5G Advanced activities.

A pivotal TSG-wide workshop is scheduled for March 2025, following the Rotterdam 6G use case event [3]. It will feature joint and parallel sessions across RAN, SA, and CT, focusing on system aspects and 6G study organization. With one contribution per company or MRP allowed, European collaboration will be crucial. Technical studies on 6G radio and core architecture will begin in June 2025. Release 21 aims to deliver 6G specs for IMT-2030, with ASN.1/OpenAPI freezes not expected before March 2029, ensuring a gradual evolution from 5G. Meanwhile, 5G Advanced continues to develop. Finalized in June 2024, Release 18 brought enhancements like improved energy efficiency, slicing, and vertical support. Release 19 (expected late 2025) builds on this with higher-bandwidth support and better URLLC, benefitting sectors like autonomous vehicles and smart manufacturing. Release 20, likely finishing by late 2025, bridges 5G Advanced and early 6G with more advanced AI and IoT capabilities. RAN Working Groups made significant progress across multiple releases:

- **RAN1** improved physical layer aspects, including MIMO enhancements, LP-WUS for FR2, XR support, and multi-carrier uplink scheduling.
- **RAN2** focused on AI/ML for mobility/resource management, Ambient IoT, and energy-saving mechanisms such as dynamic SIB1 configurations.
- **RAN3** refined NG-RAN architecture, femto cell modes, data collection for mobility optimization, and multimodality for XR.
- **RAN4** finalized most of Release 18 and progressed with Rel-19 testing, including beam management, FR2 OTA testing, and AI-driven CSI handling.

Collectively, these developments solidify the path from 5G to 6G while reinforcing Europe's strategic position in shaping future mobile networks.

III.   RECENT ACTIVITIES IN ETSI AND ITU TOWARDS 6G

The European Telecommunications Standards Institute (ETSI) is only one of the three bodies recognised by the EU as a European Standards Organisation, with members foremost concentrated in Europe. This organisation has five industry standardisation groups (ISG) which are relevant for advanced 5G/6G pre-standard research: ETSI ISG Zero touch network & Service Management (ZSM), ISG Terahertz (THz), ISG Experiential Networked intelligence (ENI), ISG Integrated Sensing and Communication (ISAC) and ISG Reconfigurable Intelligent Surfaces (RIS). To further support 6G, ETSI has developed open-source projects that include TeraFlowSDN for software-defined network control, OpenSlice for network-as-

a-service support, and OpenCAPIF for secure API access. These initiatives, supported by several European projects, aim to build a comprehensive toolkit for advanced network deployment and management. Besides, several related groups are of interest towards 6G: Research, Innovation and Standards Ecosystem (RISE) group as well as the ETSI Technology Radar for Integrated Sensing and Communication.

In 2024, the ITU's IMT-2030 framework progressed by refining 6G requirements, emphasizing seamless connectivity, high bandwidth, ultra-low latency, and large-scale device support. Building on its 2023 approval, ITU is defining technical criteria and evaluation benchmarks through 2027. The framework supports immersive applications, intelligent networks, and broad coverage across diverse environments, while promoting energy efficiency and green technologies. Together, ITU and 3GPP efforts offer a cohesive path toward 6G, laying a strong foundation for the transition from 5G.

IV. PRE-STANDARDISATION ACTIVITIES IN THE 6G-IA

The 6G-IA Pre-Standardization Working Group (WG) supports alignment between SNS-JU projects and key regulatory bodies like ETSI, 3GPP, and ITU-R, contributing to a unified European 6G strategy. In 2024, a new standardization group was launched under the SNS-JU Policy WG to streamline priorities for 3GPP and address policy topics like security, sustainability, and EU autonomy. This subgroup, supported by both public and private sectors, began its work in October 2024 and plans bi-weekly meetings to identify key standardization areas and analyze the landscape using tools like IPlytics.

V. ANALYSIS OF CONTRIBUTIONS OF SNS PROJECTS TO STANDARDISATION BODIES

According to the survey to SNS projects run by SNS OPS and as shown in Figure 2, ETSI and 3GPP continue to be the most popular targets for contributions for Call 1 and 2 projects.
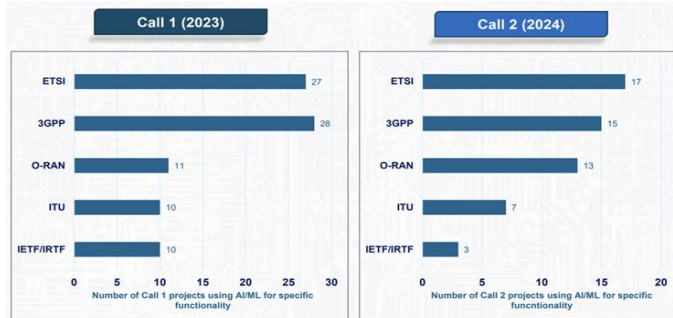

Figure 2: Contribution projects to standard bodies.

Interestingly, an increase can be observed in the contributions to O-RAN at the expense of those to the Internet Engineering Task Force (IETF)/Internet Research Task Force IRTF. The majority of 3GPP contributions by SNS projects are aimed at the System Architecture (SA2) specification group due to the given 3GPP timeline and the planned workshop in March 2025, which will focus on core network and system aspects. The high number of contributions to O-RAN Radio Intelligent Controller Workgroup (WG3, WG2) and ETSI Zero-touch

network and Service Management (ISG ZSM) can be similarly explained, as they strongly relate to system aspects at this stage. As for open-source contributions to WGs in standardization bodies and open-source projects, its number has substantially increased from only 23 in Call 1 to 67 open-source contributions in Call 2 projects. Most of these contributions, 28, are geared towards radio access networks (Open-RAN, OpenAirInterface, SRSRAN). In the first call, in total 132 open-source solutions were used. The top-ranked open-source solutions which projects made use of are: in the core (e.g. Open5GS, FreeGC), cloud (e.g., Kubernetes, Docker), followed by smaller areas Radio, Support Systems.

VI. CONCLUSIONS AND RECOMMENDATIONS

Standardization is essential for interoperability and global competitiveness, with a strong push toward a unified 6G standard. Key organizations are aligning on spectrum, architecture, and societal impacts to support a resilient global 6G ecosystem. Major efforts are underway in 3GPP and ETSI, with milestones like 3GPP Release 20 (2025) and Release 21 (2030), and ETSI initiatives on Terahertz and Zero-touch Networks. Europe is taking a leading role, collaborating with ITU, ETSI, and 3GPP, and contributing through 6G-IA's pre-standardization group and the SNS-JU Policy WG. SNS projects increasingly contribute to both standards and open-source efforts, especially in core network and system areas.

To sustain Europe's leadership in telecom and maximize its 6G standardization impact, stakeholders must take a coordinated, proactive approach. Based on this paper's analysis, SNS ICE offers tailored **recommendations**. The **SNS Office, public sector, and policymakers** should strengthen support for standardization by encouraging systematic participation in ITU, 3GPP, and ETSI, and incentivizing EU-funded R&I projects to contribute to global standards. For the **telecom industry**, active engagement in international standardization is key to influencing 6G specs, with early attention to end-user needs. **Academia and SMEs** should lead or support pre-standardization in areas like spectrum sharing and low-power communication. **Cross-sector coordination** is vital to ensure strong European representation and leadership in global 6G efforts.

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